

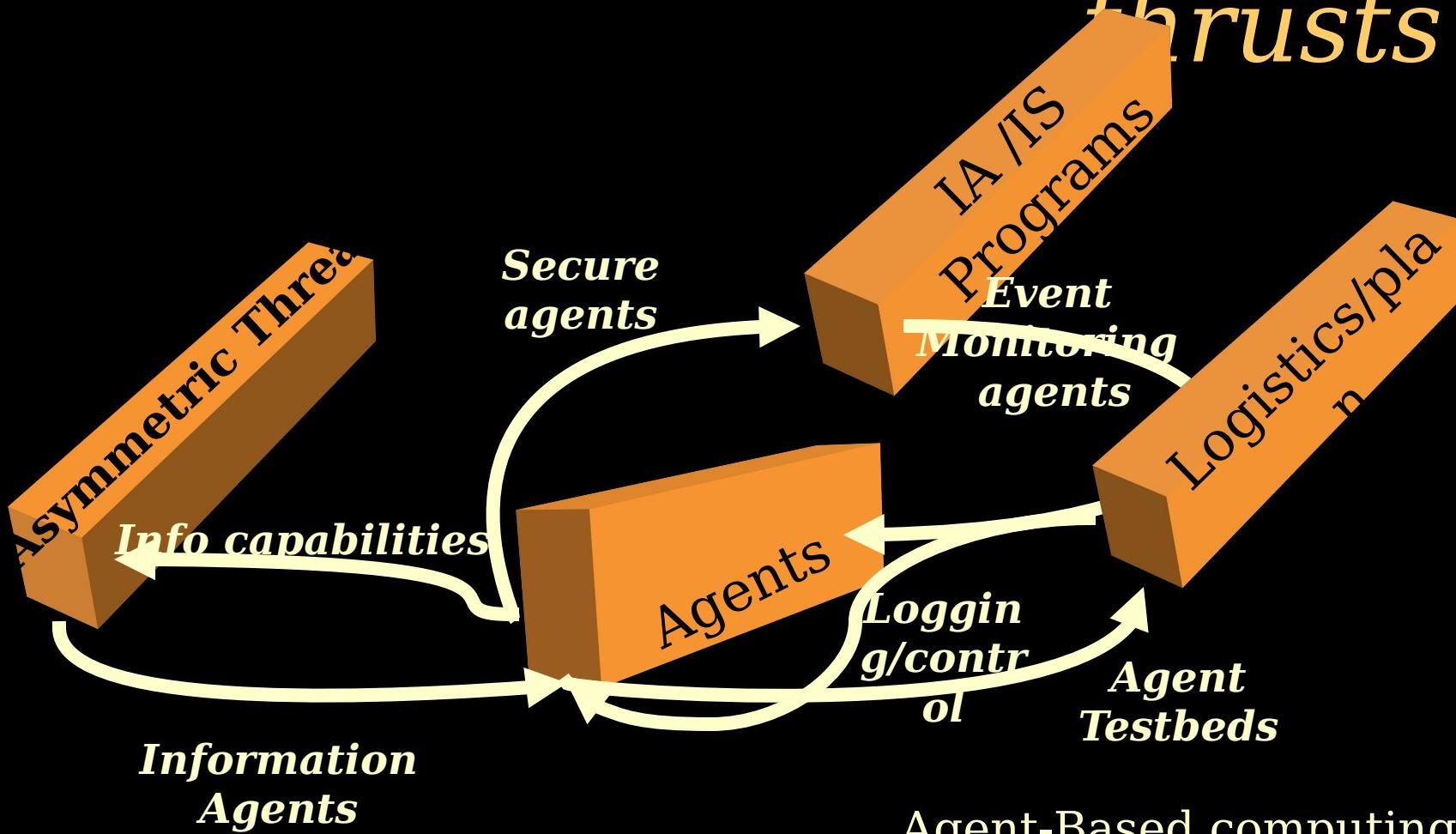
Agent-Based Computing



DAML DARPA Agent Markup Language

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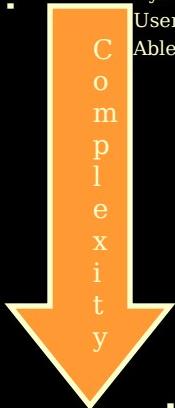
Agents are crucial to ISO thrusts



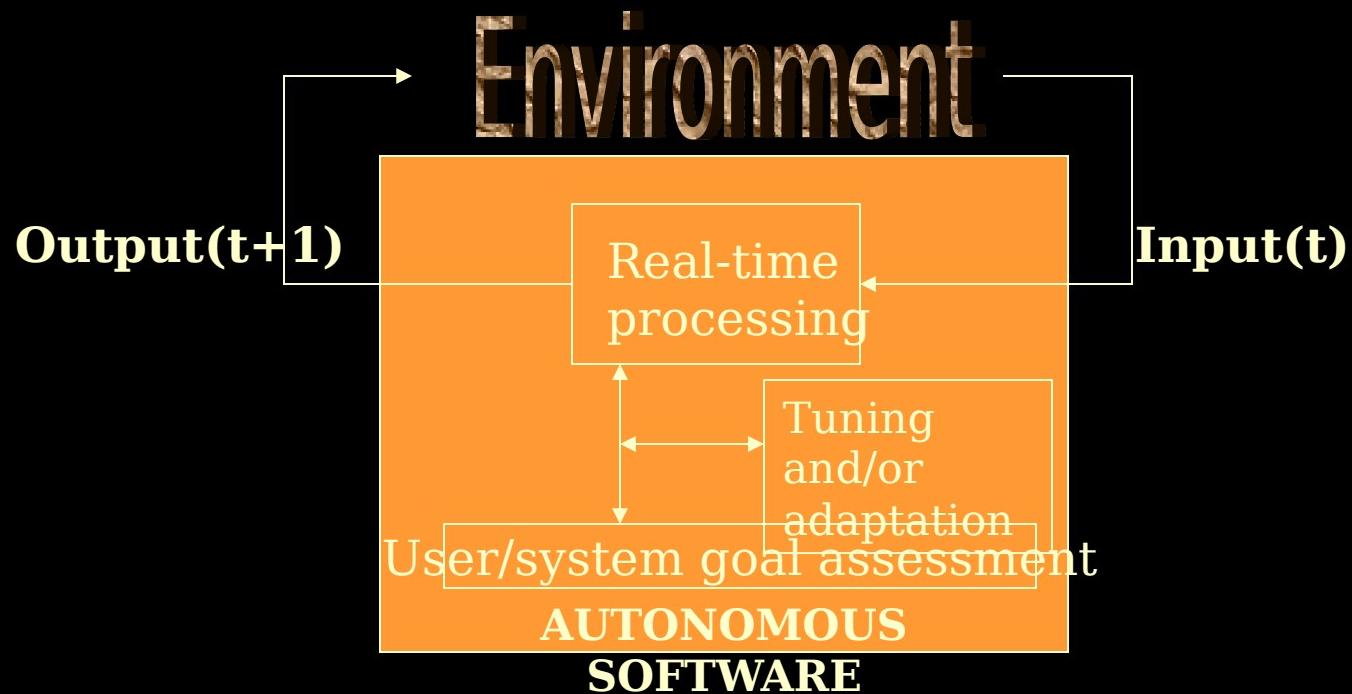
Agent-Based computing is mandatory for delivering on the key ISO themes. As functionality is gained, all

What is an agent?

- An agent is a software component or system that is:
 - Embedded in, and “aware” of, an environment
 - Dynamic in its behaviors (not single I/O mapping)
- User enabled/steered, but “empowered” to act for user
Able to improve its behavior over time

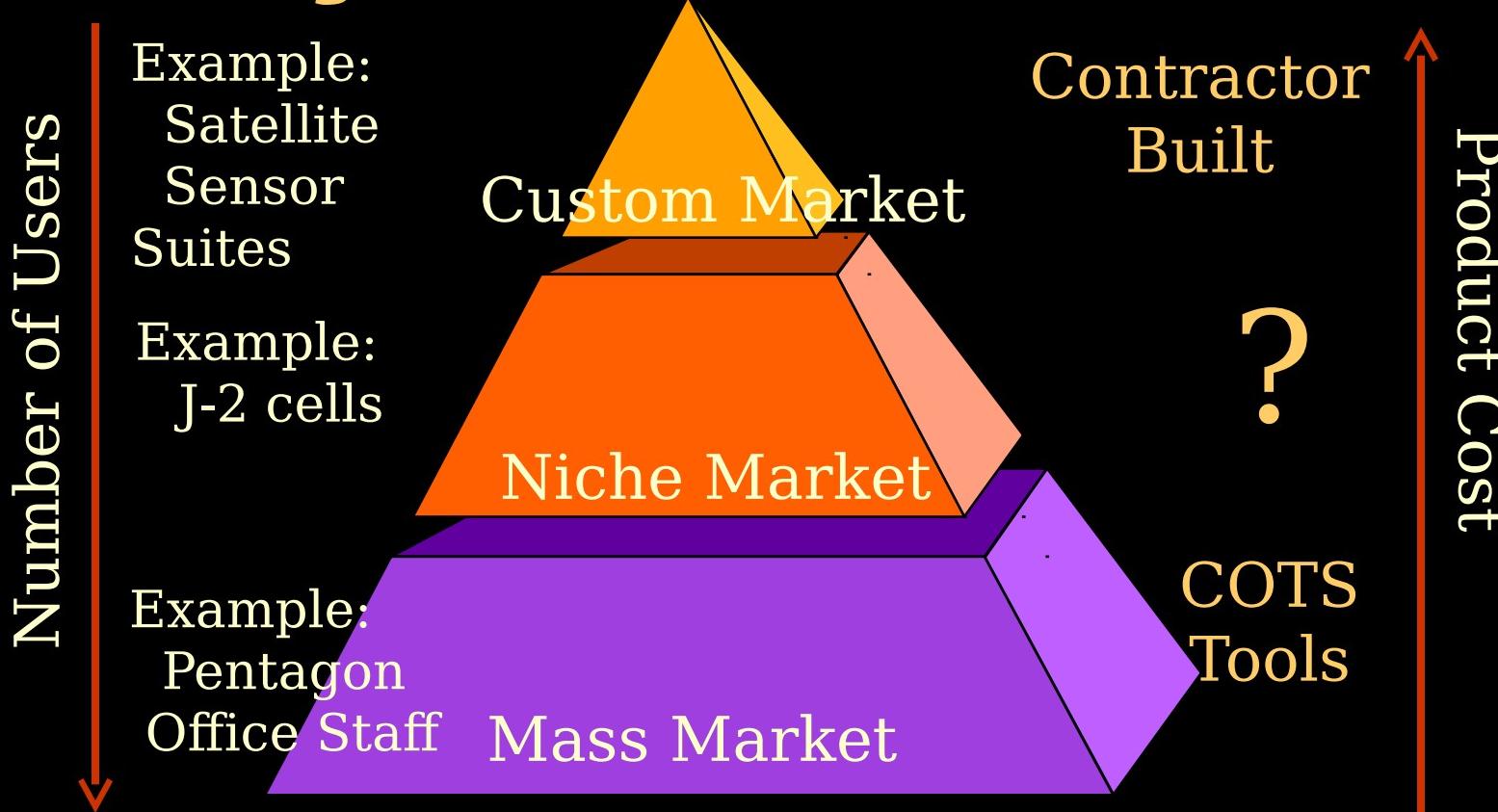


Communicative
Autonomous
Capable
Adaptive



These are
desirable
properties
for software
systems

Military Tools



- The military is made up of many different markets
 - Some custom markets w/successful transitions
 - Some markets covered by COTS tools
 - Middle niche largely unsuccessful transitions
 - Custom code not POMed because other users won't pay
 - COTS tools won't address because of mil. specific needs
 - Tool cost outside IDIQ type arrangements

Military Task-Specific Tools

What was the most important piece of software ever?

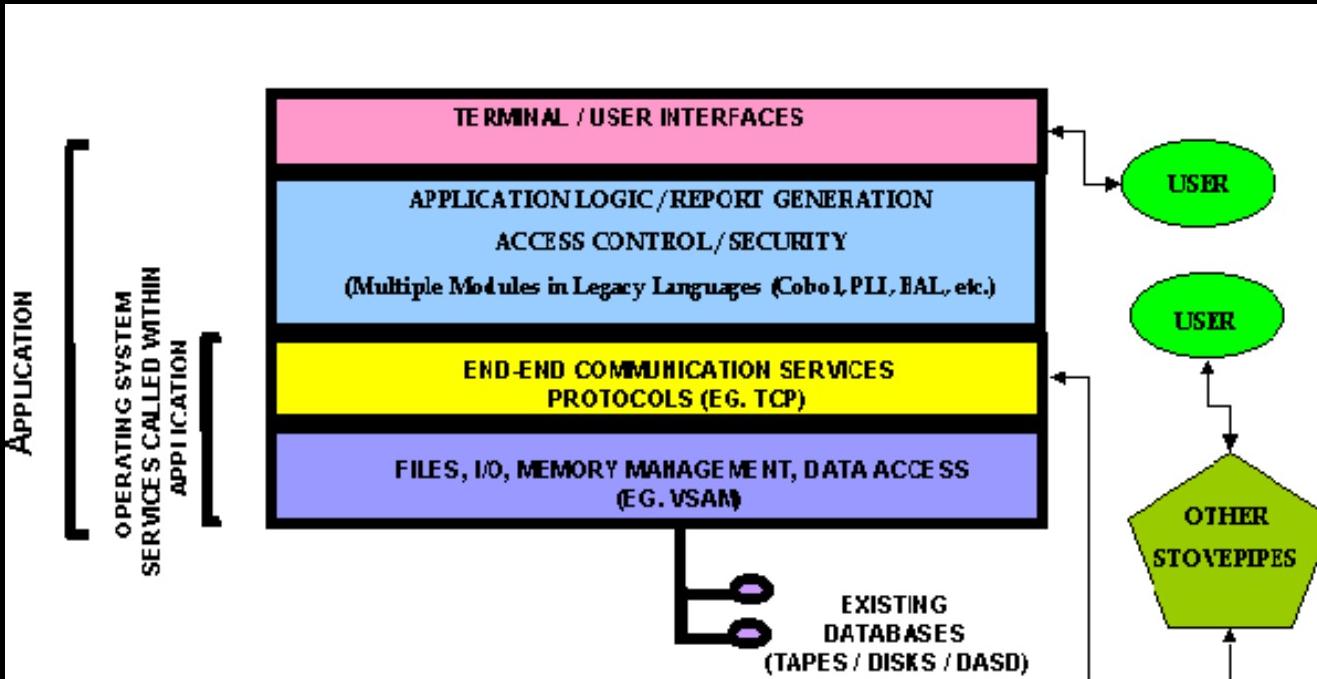
The original “killer ap” - **VISICALC** (now Excel)

- Before
 - Hire programmers
 - Explain your domain
 - Take versions as provided
 - Pay continually for update and maintenance
 - Dependent on outsiders
- After
 - “Programmed” in-house, users already know task
 - Immediate feedback/prototyping
 - Continually updated by users, in-house
 - no external dependence

Same story for Powerpoint - most used piece of “military

Contention: Information Agents are a key enabling technology for building similar task-specific tools for military users.

Why is this hard



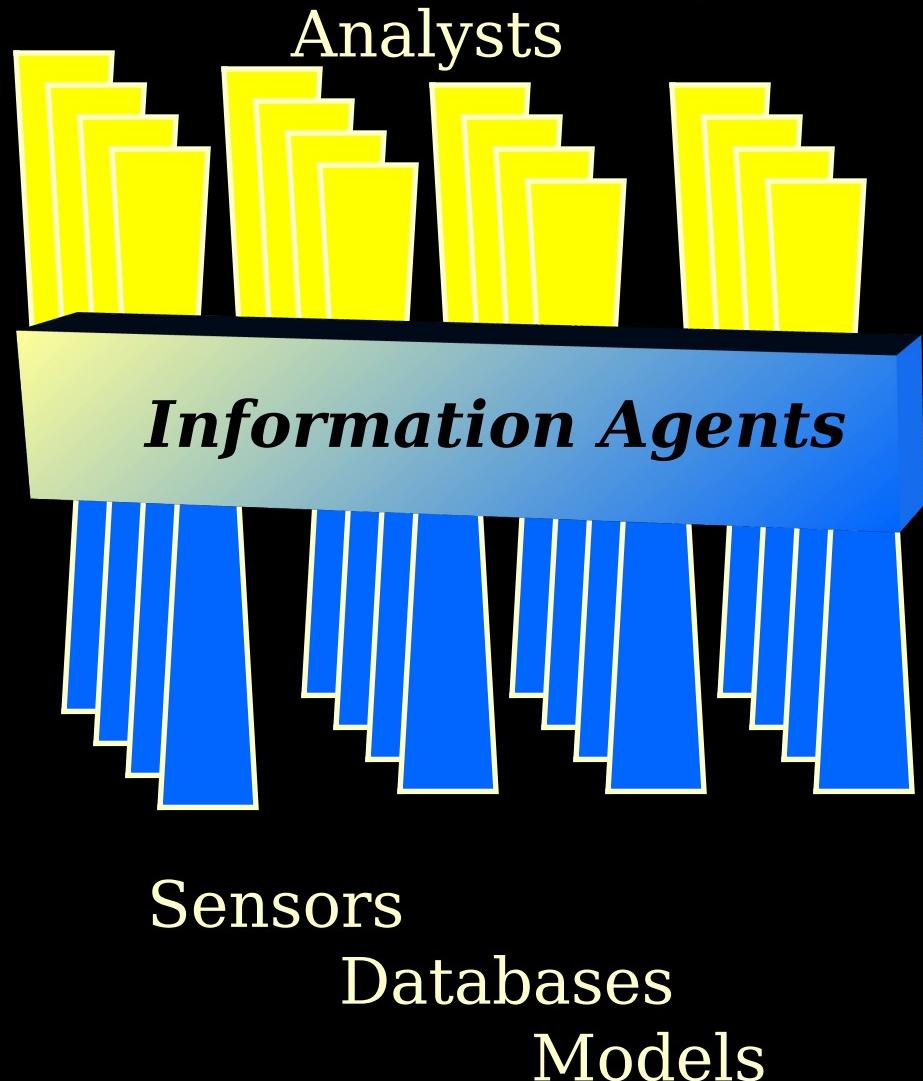
Most military information systems are in stovepiped systems

Difficult to get access to the sources

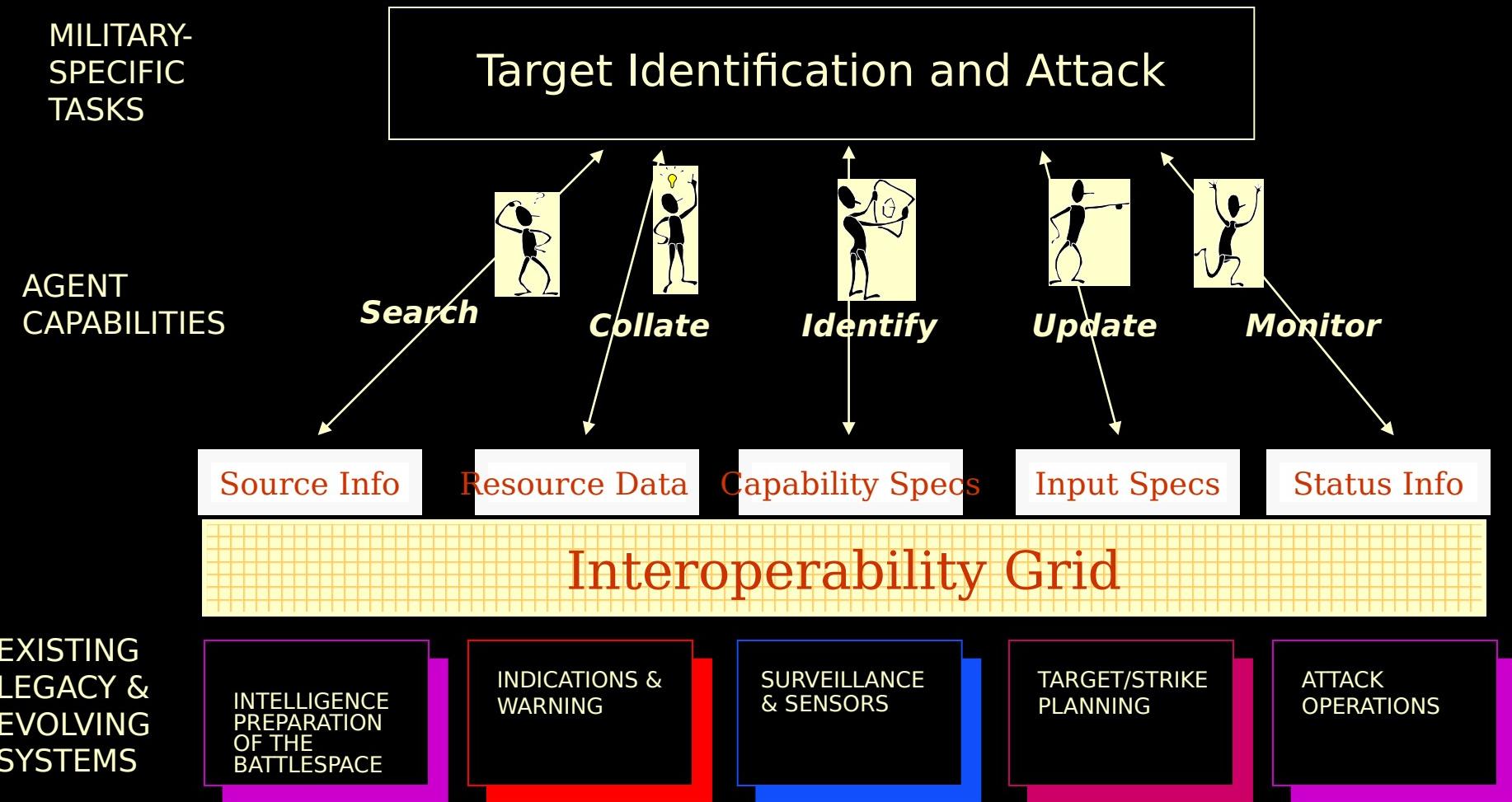
No mechanism for remote access

How Agents Help: Breaking down the stovepipes

- Provide tools to help the run-time coupling of decision-making and analysis tools with appropriate data and sensing resources
- Development is focused on (shared) **information** needs



Information Agents



What does it take?

- A three-program approach
 - I. A mark-up language for networked agents
 - **DARPA Agent Mark-Up Language (DARPA AML)**
 - Must provide a mechanism for advertisement/capability specs
 - II. Software tools for creating the agents
 - **Taskable Agent Software Kit (TASK)**
 - Must reduce per-agent development/customization cost
 - III. A middleware layer creates a “software grid”
 - Continuation of **CoABS** investment
 - Must be able to bring systems, sensors, models, etc. to the grid

*DARPA Agent Markup
Language(DAML)*

Problem: shared representation

- We never were able to develop monolithic data standards in the military(motivating this work in the first place)
 - Why should we be able to develop monolithic common-sense ontologies or agreed upon domain models for sharing the grid?
- Solution:
 - Develop usable interoperability technologies similar to those that enable the world-wide web to function

How do we attack this problem?

- The key enabler of current interoperability in both military and commercial systems is the “HyperText Mark-up Language” (HTML)
 - Allows a machine readable, formal language, to be expressed on web pages for the presentation of data
 - limited set of tags
 - not useful for machine search

```
<Title> How do we  
attack this problem?  
</title>
```

Beyond HTML: adding syntax

- Current languages attack this by adding syntactic data handling abilities
 - XML (eXtensible Markup Language)
 - Extensible keyword set
 - Solves syntactic inequalities between data formats
 - DB 1 -> ADDRESS <- DB 2
 - Useful for Data Sharing
 - Not search
- ```
<!Element TITLE-BLOCK EMPTY>
<!ATTLIST TITLE-BLOCK Title #cdata required Subtitle #cdata
implied>
<Title-Block>
 <title> Beyond HTML </title>
 <subtitle> adding syntax </subtitle>
</title-block>
```

# *Beyond XML:Agent Semantics*

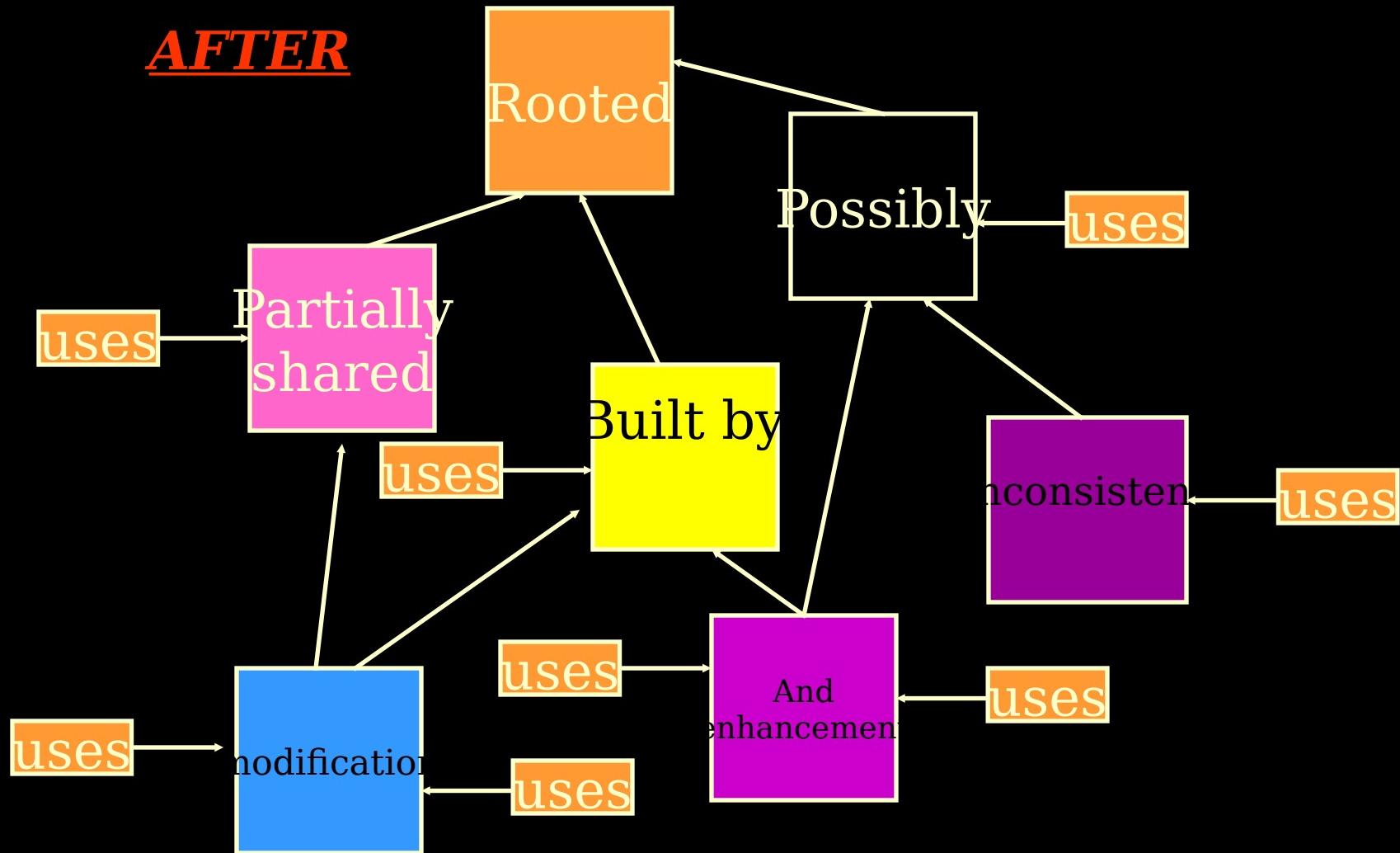
- DARPA will lead the way with the development of Agent markup Language (DAML)
  - a “semantic” language that ties the information on a page to machine readable semantics (ontology)
  - Currently being explored at University level
    - SHOE (Maryland), Ontobroker(Karlsruhe),OWL(Washington Univ)
    - Largely grows from past DARPA programs (I3, ARPI)

```
<Title> Beyond XML
 <subtitle> agent semantics </subtitle>
</title>
<USE-ONTOLOGY ID="PPT-ontology"
VERSION="1.0" PREFIX="PP" URL=
"http://iwp.darpa.mil/ppt..html">
<CATEGORY NAME="pp.presentation"
FOR="http://iwp.darpa.mil/jhundler/agents.html">
 <RELATION-VALUE POS1 = "Agents" POS2 =
 "&#hundler">
```

- But not transitioning
- W3C focused on short-term

```
<ONTOLOGY ID="powerpoint-ontology" VERSION="1.0"
DESCRIPTION="formal model for powerpoint
presentations">
 gain:HTML/XML
 <DEF-CATEGORY NAME="Title" ISA="Pres-
Feature" >
 <DEF-CATEGORY NAME="Subtitle" ISA="Pres-
Feature" >
 <DEF-RELATION NAME="title-of"
 SHORT="was written by">
 <DEF-ABC POS=1>
```

*This leads to a radically new view of semantics!*



# *A distributed ontological representation*

- Small communities define common semantics
  - Modifying existing components
    - adding terms
    - overwriting existing terms
    - deleting old terms
  - Creates a “rooted, directed, acyclic, graph” (rDAG)
    - Any two pages have at least one common ancestor
      - precisely defining shared terms
      - syntactically representable with a naming convention
  - Allows for an “ontology calculus” similar to the relational calculus that makes DBMS possible!
    - Will make “ontology management systems” a reality!

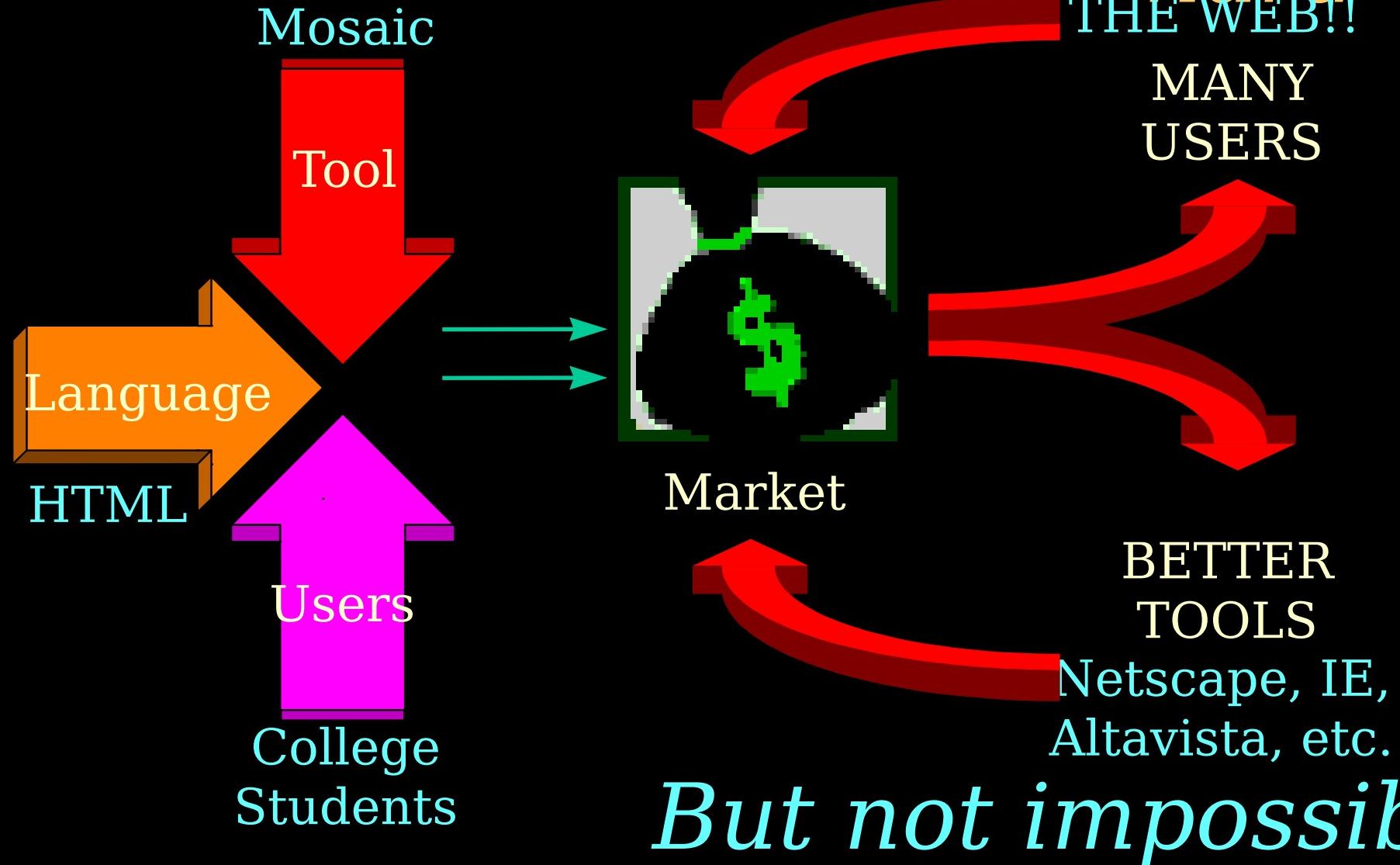
# *Advantages*

- Allows semantic interoperability at the level we currently have syntactic interoperability in XML
  - revolutionizing web interoperability
- Objects in the web can be marked (manually or automatically) to include the following ***information***
  - Descriptions of data they contain (DBs)
  - Descriptions of functions they provide (Code)
  - Descriptions of data they can provide (Sensors)
- This marks the environment for agents!
  - Remember the dog analogy
    - This is the “scent,” as it were

# *Military Utility*

- Enables flexible tools for military software development and use
  - Information gathering
    - Agents can use DAML/ontology for search
  - Software development
    - Algorithms/code fractions advertise critical properties
  - Coupling of legacy systems
    - “Agentization” of systems enabled through grid interoperability mechanisms
      - advertise capabilities in DAML

# *Language adoption is hard*



# *DAML will do the same*

- DARPA funds language development
  - DAML instead of HTML
- DARPA funds “Killer Ap”
  - Intelligence tools for InteLink
- Tool released to military
  - Tools generate DAML links
- Market formed
  - 55,000 (and growing) users of InteLink enough to attract business investment

- Military spends a huge amount of time creating briefings

- gathering, collating, formatting data
- translating into powerpoint slides
- customizing for different commanders

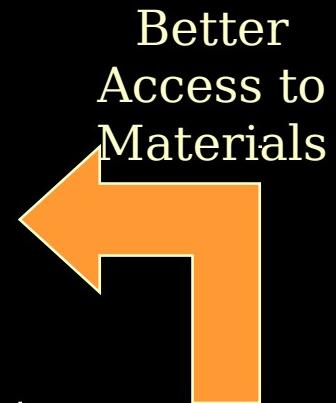
- Need for a Personalized Briefing Creation Agent

- Knows about military domain (communicative)
- Knows how to access military sources (capable)
- Gathers information off-line for user (autonomous)
- Tailorable to users needs and changing resources (adaptive)

- Need for a search tool for information embedded in briefings

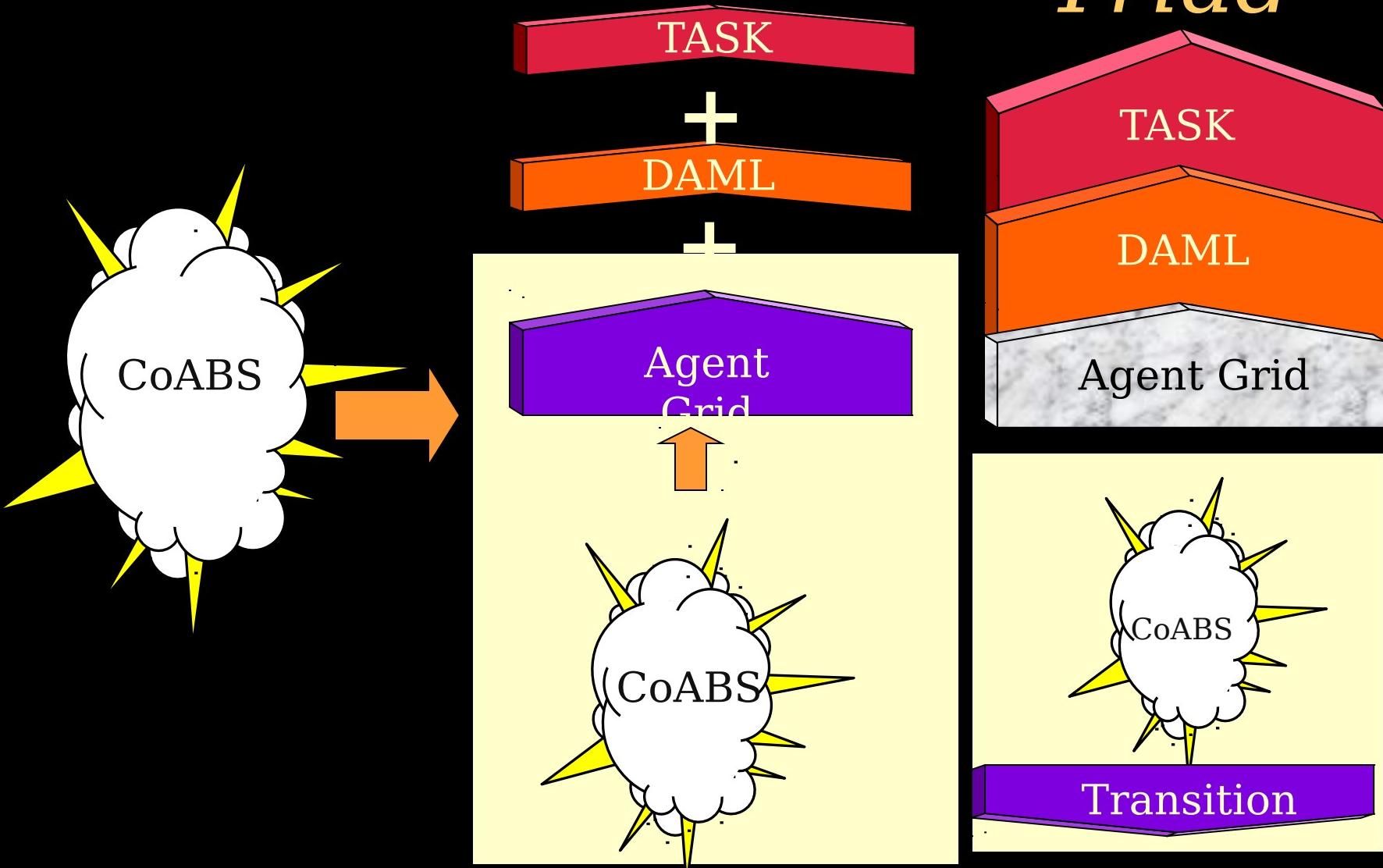
- IntelLink minimally keyword searchable

# *The Killer Ap*

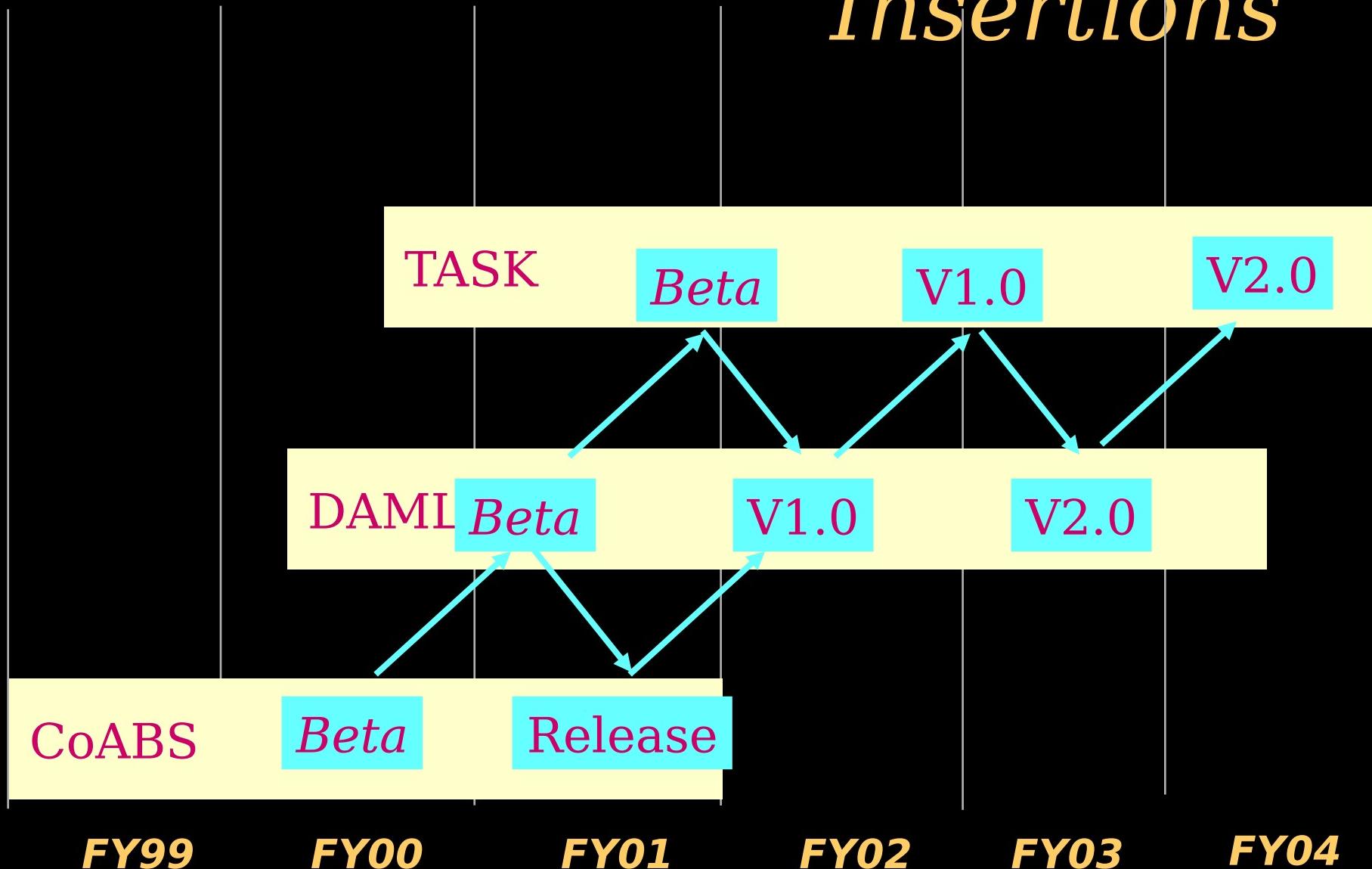


# *Agent Based Computing*

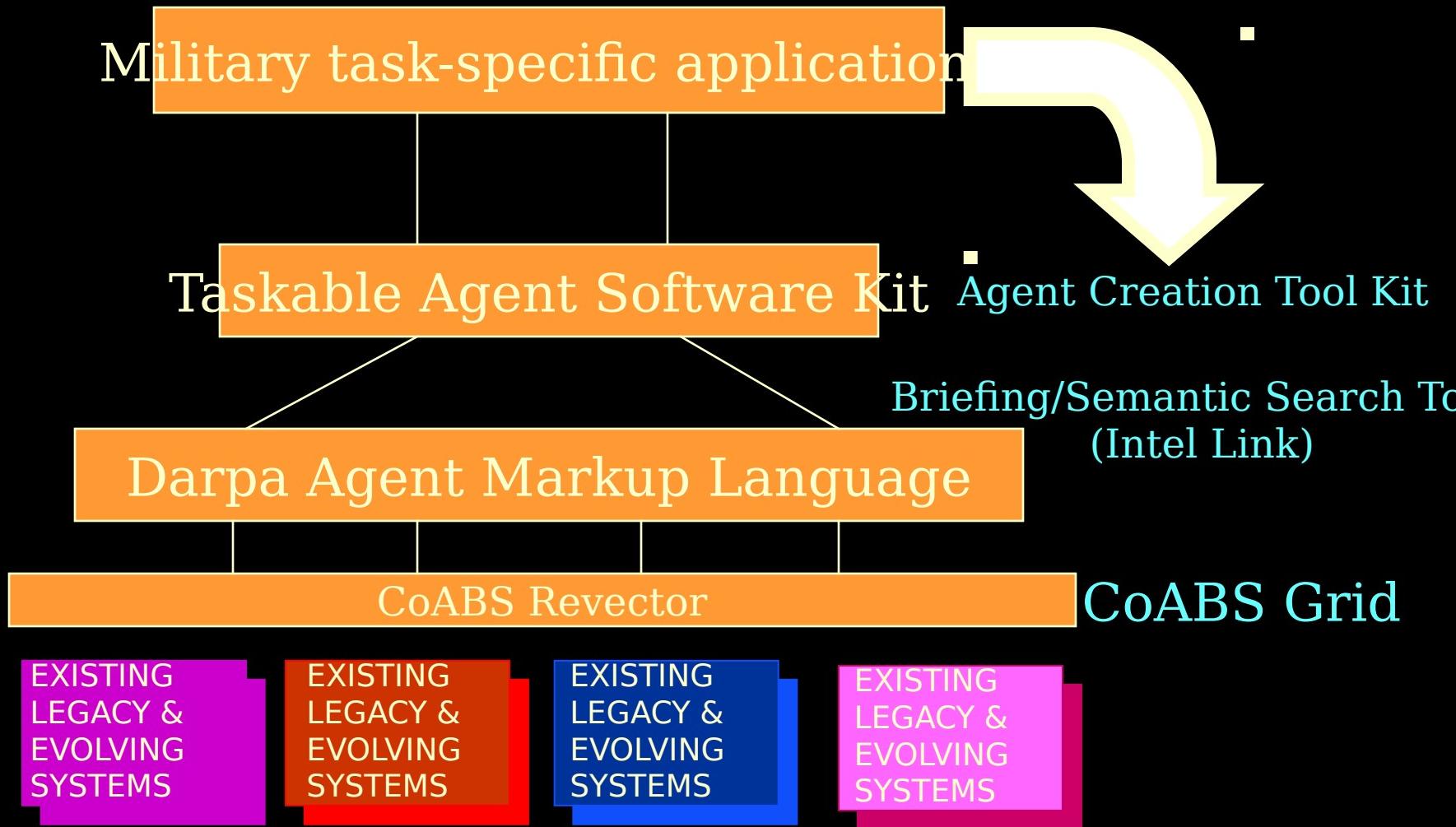
## *Triad*



# *Scheduled Technology Insertions*



# *Leave Behind*



# *Final Thought*

*Are the information people in MIS and IT prepared for the revolution? I see no sign of it so far.*

(P. Drucker, Forbes, Aug. 1998)

*DARPA must lead the way!*

**END**